

there are many, no doubt, who would have expected that at least a portion of the Hyperiidæ would be equally abundant.

But what was really the case? Why, scarcely any *Hypericæ* at all—that is, so far as I have observed. True, I have not been able, from ill health, to look after the matter so much, nor give it the attention, this summer, that I should have liked; still I have been out; and had they been there, I do not think they could have escaped my notice.

It chanced that one day in July, and two in August, great hordes of the *Medusæ* were cast in upon our beach; and out of many hundreds of these, which I had the satisfaction of examining, and that carefully too, I only got seven *Hypericæ*—one *L. Kinahani*, and six *H. galbæ*. The first was adult, but none of the others. Two, on these occasions, were the most found in a single *Medusa*. Thus these seven, and about thirty others which I obtained free, are all my season's take—that is, of these two species—making in all about two score. Yes, only two score, and that, too, when, as I have already stated, the *Medusæ* were in such prodigious shoals that they were never known to be so numerous in this part of the sea before.

On the other hand, I have met with *L. Kinahani* and *H. galba* very plentiful whilst not a *Medusa* was to be seen and there was perhaps not one in this part of the Firth.

Such, then, are a few and rather briefly told facts concerning these curious and interesting creatures—a genus whose true habits and economy seem, as yet, to be but little understood. And if I have been able to add to their general character even but one single fact not hitherto known, I shall consider myself well rewarded for my time and labour—a labour which is to me at all times a pleasant occupation.

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Experimental Investigations with Cestoid Entozoa. By T. S. COBBOLD, M.D., F.R.S., F.L.S., Lecturer on Comparative Anatomy at the Middlesex Hospital.

[Read Nov. 1, 1866.]

Having from time to time in conjunction with Professor Simonds carried on a series of experiments which (so far, at least, as I was concerned) were originally promoted by a small grant of money placed at my disposal by the General Committee of the British Association, the present record may, in some sense, be regarded as a continuation of our joint Paper communi-

cated to the Royal Society \*. During the past year, however, the incessant demands on Mr. Simonds's time (occasioned by the rinderpest epidemic) have left him so little leisure that he has desired me to make use, in any way which I might think fit, of the results thus unitedly obtained. I may remark that the procuring and selecting of our experimental materials (such as trichinous flesh and tapeworm-proglottides) generally devolved upon myself, whilst, on the other hand, the actual administrations were made either by Mr. Simonds or by Mr. Pritchard, the Assistant Professor and Anatomical Demonstrator at the Royal Veterinary College. On these occasions other persons, as well as myself, sometimes rendered aid. I may likewise add that I do not here record certain experiments which Mr. Simonds conducted independently, but only those for which I may rightly be considered exclusively responsible.

*Tænia mediocanellata*.—Exp. 1. This successful case, in which about 8000 tapeworm-larvæ were reared in a calf, is already fully reported in the Proceedings of the Royal Society for May 4, 1865, No. 75, vol. xiv. p. 214.

Exp. 2. Four separate worm-feedings were administered to a calf, namely 50 sexually mature proglottides of *T. mediocanellata* on the 13th of April (1865), 160 proglottides on May 16th, 120 proglottides on June 1st, and a final hundred on the 17th of the last-named month. Mr. Simonds states that this animal gave no evidence of helminthic symptoms. On the 2nd of September it was attacked with rinderpest, and died in 36 hours. I had not myself an opportunity of examining its flesh, and Mr. Simonds failed to detect any cysticerci in the muscles.

Exp. 3. In this case the experimental animal was a fine healthy Dutch heifer, about two years old. On the 3rd of March she swallowed 90 proglottides given in tepid water. On the 15th of the same month 108 proglottides were also administered. On the 5th of April another 100 joints were given; and for a few days after she seemed rather restless, bellowing occasionally. No other symptoms having followed, on the 13th of the succeeding April I made a very careful selection of 200 ripe proglottides, from specimens which I had that day received from Birmingham, through the kindness of Dr. Fleming. For some some days the restlessness appeared to increase slightly, and the bellowing continued. In addition there were certain peculiarities of manner

\* "On the Production of the so-called 'Acute Cestode Tuberculosis' by the administration of the Proglottides of *Tænia mediocanellata*."

which convinced Mr. Simonds (who watched the animal almost daily) that we had here, at least, a feeble development of those symptoms of the "acute cestode tuberculosis" which were so strongly marked in our first experiment on a calf. There was the same vacant stare, a dull expression of the eye, slight arching of the back, and stretching of the limbs. However, the heifer never lost her appetite, and, strange to say, whilst all the cattle near her were attacked by (and most of them died of) the rinderpest, she entirely resisted its invasion. In about a week all the measles-symptoms passed off, and in course of time the animal attained the proportions and aspect of a large, healthy, three-year-old cow. It was not until the expiration of rather more than a year from the time of our first feedings, namely on the 4th of April 1866, that the beast was slaughtered. With Mr. Pritchard's assistance I made a very careful dissection and examination of the beef thus obtained; nor was it until I had subjected the muscles for many minutes to a very close and careful scrutiny (with the aid of a pocket-lens) that I succeeded in detecting evidence of the successful character of our experiment. The result was most interesting, especially since none of the previously recorded experiments (either by ourselves or those previously instituted by Leuckart and Mosler) had extended over such a period of time. Here the only indication of the presence of measles was shown by the existence of extremely minute calcareous specks, larger, it is true, but by no means so conspicuous as ordinary *Trichinacapsules*. They presented the aspect of sparsely scattered yellowish points without any definite outline or any other character likely to catch the eye. It is even difficult to see them in sections of the flesh which I have expressly preserved to show them. Microscopic examination affords evidence of the remains of a small cyst; but all trace of the measles itself is entirely lost. Each cysticercus had become, as it were, resolved into a more or less amorphous, solid, friable, crystalline particle, whose true characters (as presented to the naked eye) were obscured by a closely investing and remarkably contracted cyst, the external surface of the latter becoming insensibly blended with the ordinary intermuscular connective tissue. By a little care, however, the calcareous particles could be perfectly isolated from their cysts. They were numerous and, owing to the deeper colour of the muscular substance, most easily found in the diaphragm. In other muscles they were, perhaps, equally abundant, but it was a great labour to find them. Assuming them to have been pretty equably

distributed throughout the muscular system, there could not have been less than 12,000 of these degenerated measles in the animal. I have no hesitation in saying that, if there had been 12,000,000 of these measles, no butcher would ever have noticed them; but, fortunately, in this condition their ingestion could do no possible harm. In point of fact, the flesh of the animal has since been entirely eaten; and healthier beef I never saw. Even in their perfect, non-degenerated state, the beef measles are readily overlooked; and until recently no person besides Mr. Simonds, Mr. Pritchard, and myself, and those who assisted us, had even seen them in this country. The experiment now recorded is the first in which the natural process of cure has been traced; and it is of great practical importance, inasmuch as it proves to demonstration that a period of ten or twelve months is fully sufficient to ensure the natural death (by calcareous degeneration) of the smaller tapeworm-larvæ which reside in cattle. This is a positive contribution to our knowledge of the life-economy of these smaller cysticerci, and it serves to fix the period of their larval activity. All the entozoa, in their juvenile stages, whilst occupying the flesh of man and animals are liable to be affected by this law of calcareous degeneration; but the actual time required to bring about the death of the parasite varies considerably in different species.

*Tenia serrata*.—Exp. 1. Three examples of the pea-shaped hydatid (*Cysticercus pisiformis*) were removed from the abdominal viscera of a recently killed rabbit. Two of them were rather more perfectly developed and larger than the third. The rabbit harboured no others. These three cestode larvæ were administered, on the 25th of January 1865, to a healthy puppy, reared at the Veterinary College and nearly twelve weeks old. Five days subsequently, namely on the 30th of the same month, the puppy was destroyed. In the alimentary canal I found three young *Tenias*, and three only. Two of them were severally about 1 inch in length, the third being a trifle shorter and not quite so large. These sexually immature tapeworms presented all the true characteristics of *T. serrata*, and their degree of development was in exact accordance with my previous experiences in this relation. The more feeble development of the third tapeworm proved its genetic connexion with that larva which at the time of the worm-administration was noticed and recorded as being rather incompletely developed. The experiment was a perfect success.

Exp. 2. On the 25th of January, 1865, a second rabbit was destroyed, for the purpose of procuring additional tapeworm-larvæ.

In this rabbit I only found one solitary and perfect *Cysticercus pisiformis*—a somewhat unusual circumstance. Mr. Simonds placed this larva in a small piece of paper, and in the form of a bolus gave it to a little puppy which belonged to the same litter as the former, being readily distinguished by its black ears. We did not destroy this whelp until the 7th of the following February, thus allowing a period of thirteen days to elapse for the development of the solitary *Tænia serrata* which we desired to rear from the cysticercus. Mr. Simonds, as usual, requested me to examine the alimentary canal; and I had the satisfaction of removing the solitary *Tænia serrata* we had thus successfully reared. It was just 6 inches in length, showing the same correspondency as to growth, in respect of time, which my previous and independent experiences with the artificial method of rearing this parasite had invariably supplied. The proglottides were still immature, but the cephalic development was in all respects complete.

*Tænia marginata*.—On the 28th of January, 1865, Mr. Simonds removed fourteen specimens of the so-called slender-necked hydatid from the omentum and surrounding viscera of a hogget. Five of these large cysticerci (*C. tenuicollis*) were administered to the mother of the two whelps above referred to. They were swallowed entire, without any additional material. This dog was killed on the 7th of the following February, thus allowing only ten days for the development of the corresponding adult tapeworms. As usually happens in all old dogs, we found in the intestinal passages many examples of the extremely common cucumerine tapeworm (*T. cucumerina*); but these of course could have no genetic relation to the tapeworm-larvæ, which latter were already known to be the offspring of an entirely different species of cestode parasite. Our experiment, indeed, was a perfect success; for, in addition to the cucumerine tapeworms (of which there were fifteen mature specimens of variable size and growth), I found in the duodenal portion of the intestinal canal five young and sexually immature examples of the *Tænia marginata*. These were of uniform size and severally 1 inch in length. Not a shadow of doubt could be entertained as to their relation to the five cysticerci which had been administered. Their specific characteristics, uniform development, degree of growth, and separate location in the canal, pointed unequivocally to the source whence they had been derived. Here again, therefore, previous experiences received abundant confirmation.

*Tænia cænurus*.—Exp. 1. On the 15th of March, 1865, Mr.

Simonds received (from Messrs. Caudwell, of St. Neots) the head of a "giddy" sheep which had been killed two days previously. On examination the brain was found to contain a perfect polycephalous hydatid (*Cœnurus cerebralis*) which, it was estimated, supported about 150 scoleciform processes, or larval tapeworm-heads. It was removed entire, and given by Mr. Simonds to a dog, which swallowed the parasite readily in its unbroken condition. Only five days subsequently, namely on the 20th of March, the experimental animal was destroyed; and here again a complete success attended our experiment. A careful examination of the alimentary mucus enabled me to extract a large number of extremely minute tapeworms, of so small a size that they were scarcely visible to the naked eye. Though only the heads and necks were developed, their characters corresponded with what was hitherto known of the head and neck of *Tænia cœnurus*, to which species they were undoubtedly referable. Their number appeared to correspond precisely with the number of scoleces attached to the common "gid" vesicle; but no attempt was made to collect every specimen, as that would have involved an immense amount of unnecessary labour. All trace of the vesicle common to the colony of "heads" had disappeared, the necks of the scoleces, detached by digestive action, having become rounded off and more or less pointed (according to the degree of contraction shown by each specimen while under microscopic examination).

Exp. 2. On the 6th of April, 1865, a similar administration, with a brain-hydatid furnished with about 100 cephalic processes, was performed on a stray dog. Two days subsequently, however, the animal was claimed by its rightful owner, and we had therefore, in this instance, no opportunity of ascertaining the result of our experiment.

Exp. 3. On the 25th of April Mr. Simonds received (from Mr. Mackinder, of Peterborough) the head of a sheep affected with "gid." The brain was found to contain three *T. cœnuri*. One of these, furnished with numerous heads, was given to a large half-bred lurcher dog. On the 16th of the following May the animal was destroyed, thus permitting twenty-one days for the development of the slow-growing *Tænia cœnurus*. As too often happens in the case of old dogs, the digestive passages were found loaded with a great variety of tapeworms; nevertheless it was here again quite easy for us to distinguish between the parasites which had been introduced by our experiment and those which had gained access to the canine "bearer" without our aid. Thus

there were found in this "Lurcher" several examples of the large *Tænia marginata*, six or eight specimens of *Tænia serrata*, and a few examples also of *T. cucumerina*. There were likewise some half-dozen nematodes (*Strongyli*). In addition to all these, however, there were a multitude of small tapeworms (of the species *T. cœnurus*), the longest of which did not exceed one inch and a half in length, sexually immature, and manifestly corresponding with the numerous scoleces artificially introduced. Again, therefore, despite the inconveniences always liable to attend administrations of this kind on old dogs, we had abundant proof of the success of our experiment.

Exp. 4. On the 25th of April, 1865, another of the two remaining *T. cœnuri* just mentioned was given by Mr. Simonds to a smaller dog. This hydatid was also well furnished with cephalic processes (or larval tapeworm-heads). In this case the experimental animal was not killed until more than two months had elapsed from the time of the worm-administration. On the 29th of the following June we made the necessary examination. Again we were successful. The intestinal canal contained large numbers of the *Tænia cœnurus*, there being no other kinds of entozoa present. The experiment was therefore even more satisfactory than the previous one. The largest specimens measured about 18 inches in length; but when I examined their proglottides, the contained eggs were still not quite perfectly developed. The primitive yolk-sacs and superfluous granular yolk masses were very conspicuous, but the true chorionic envelope was only in the act of forming. The swallowing of the ova in this imperfect stage would lead to no result. Probably another week or ten days would have sufficed to render all these *Tæniæ* sexually mature.

Exp. 5. On the 8th of July, 1865, a large *T. cœnurus* was given to a terrier, which was also subsequently fed with trichinous flesh. This animal died on the 2nd of August of the present year, but unfortunately neither Mr. Simonds nor myself had any opportunity of examining the contents of its viscera. A portion of its muscle-flesh was sent to me for microscopic examination, and this I found to contain encysted *Trichinæ*.

*Tænia echinococcus*.—On the 23rd of June, 1865, I sent several fresh *echinococcus*-hydatids to the College, which were on the same day administered to a dog by Professor Simonds. By an oversight this animal was not destroyed until the 18th of August, 1866, when, as regards the *Tænia echinococcus*, we obtained only a

negative result. This dog was likewise the subject of a *Trichina*-experiment in which we were entirely successful. It also harboured eleven specimens of *Ascaris marginata*, and many examples of *Tænia cucumerina*; these, of course, were introduced by natural causes.

*Tænia solium*.—The only two cestodes which I have hitherto not succeeded in rearing are the present and foregoing species. My non-success in the former case I can very readily explain—not so in the latter. Negative results, however, oftentimes prove highly instructive; and it is, even here, just possible that I may have hit upon the true explanation of my non-success in the case of *Tænia solium*. At all events it is but fair to place the facts on record.

Exp. 1. On the 30th of January, 1865, and on the 23rd of the following February, numerous tapeworm-proglottides were given to a pig, which afterwards displayed no measles-symptoms. It was destroyed on May 16th, 1865, and on examination yielded no cysticerci. Most, if not all of the “joints” first given, I subsequently ascertained to be those of *Tænia mediocanellata*, whilst those of the second feeding were from what I had previously described at the time as a “very small variety of *Tænia solium*.” I now believe the latter to have represented neither *T. solium* nor *T. mediocanellata*, but an altogether distinct and new-form cestode. If this conjecture turn out correct, the explanation of this non-success is sufficiently obvious.

Exp. 2. On the 30th of January, 1865, some of the same experimental material was given by Mr. Simonds and myself to another pig. On the 15th of March following, seventy proglottides of a *T. solium* (which I fear had been placed in spirit before transmission to me) were also administered, and again, on the 13th of April, not less than 200 proglottides of my so-called small variety of *T. solium* were likewise introduced. In this case the small “joints” were transmitted to me by Dr. Alexander Fleming, of Birmingham, along with other parasites, to which I have elsewhere referred. The pig was killed on the 30th of May, 1865, and the result was again negative. The explanation of our non-success is similar to that I have assumed to hold good in the previous case. The March feeding, certainly, might have yielded *Cysticercus cellulosæ*, but I never could ascertain who sent me the parasite, and I had not a little reason for believing that the parasite had been immersed in alcohol. My previous experiences had shown that even a comparatively weak spirit-solution effectually



destroys the vitality of the ova and their contained six-hooked embryos.

Exp. 3. On the 30th of May, 1865, thirty proglottides, and on the 17th of the following June, fifty more (the parasite, in each case, being subsequently ascertained to belong to the species called *Tenia mediocanellata*) were given to a young pig. Again, on the 22nd of June, same year, I had the satisfaction of procuring (through the kindness of Dr. M'Kendrick, Physician to the Leman-street Dispensary, London) sixty perfect, fresh, and fully mature segments of an undoubted example of *Tenia solium*. These were administered to the pig by Mr. Simonds without any delay. In this case, therefore, I had every reason to anticipate a successful result. The animal was not killed, however, until the 4th of April, 1866 (the same day as that on which the heifer was slaughtered), when no traces of any measles were detected. If, as I think quite possible, measles had developed themselves and subsequently undergone calcareous degeneration, the pale colour of the pig's flesh may have prevented my detecting them. But for the dark colour of the muscular tissue, in the case of the heifer, I certainly never should have detected the degenerated beef-tapeworm-larvæ. At all events this is the only explanation I can offer. The experiment, as regards its results, had certainly been allowed to stand over too long.

In conclusion, it may be remarked that, notwithstanding this want of success in respect of the two last-named species, we have every reason to be satisfied with the results obtained in the cases of *Tenia mediocanellata*, *T. serrata*, *T. marginata*, and *T. cœnurus*.

In addition to the above-recorded experiments with *T. mediocanellata*, it may be mentioned that we gave a sheep a single "feeding," consisting of forty proglottides of this tapeworm; but from the negative experiences previously obtained by Leuckart in this relation, I felt sure that we could only get a similar result. The recent discovery of measles (furnished with hooks) in mutton by Mr. Charles Heisch, F.C.S., and also, independently, by myself, has inclined me to look for a third and distinct species of tapeworm as the progenitor of the armed mutton-measle. I have already remarked, in the appendix to my recent practical work on "Tapeworms" (p. 83), that the species in its adult state may turn out to belong to one of the higher carnivora, and not to man. Lastly, I may add that Mr. Simonds and myself have conducted a number of experiments with *Trichina*, the results of which I shall lay before the Society shortly.